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**DEPARTMENT OF TRANSPORTATION**

**Federal Aviation Administration**

**14 CFR Part 25**

**[Docket No. FAA-2016-5909; Special Conditions No. 25-626A-SC]**

**Special Conditions: The Boeing Company (Boeing), Model 787-8, 787-9, and 787-10**

**Series Airplanes; Dynamic Test Requirements for Single-Occupant, Oblique**

**(side-facing) Seats with or without Airbag Devices or 3-point Restraints**

**AGENCY:** Federal Aviation Administration (FAA), DOT.

**ACTION:** Amended final special conditions; request for comments.

**SUMMARY:** These amended special conditions are issued for the Boeing Model 787-8, 787-9, and 787-10 series airplanes. This amendment states that the Boeing Model 787-8, 787-9, and 787-10 series airplanes oblique (side-facing) seats may be installed at an angle of 18 to 45 degrees to the airplane centerline and may include a 3-point or airbag restraint system, or both, for occupant restraint and injury protection. This airplane will have novel or unusual design features when compared to the state of technology envisioned in the airworthiness standards for transport category airplanes. These design features are oblique (side-facing) single-occupant seats equipped with airbag devices or 3-point restraints. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for these design features. These special conditions contain the additional safety standards the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

**DATES:** This action is effective on Boeing on [INSERT DATE OF PUBLICATION IN THE FEDERAL REGISTER]. Send comments on or before [INSERT DATE 45 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER].

**ADDRESSES:** Send comments identified by Docket No. FAA-2016-5909 using any of the following methods:

- *Federal eRegulations Portal:* Go to <http://www.regulations.gov/> and follow the online instructions for sending your comments electronically.
- *Mail:* Send comments to Docket Operations, M-30, U.S. Department of Transportation (DOT), 1200 New Jersey Avenue, SE, Room W12-140, West Building Ground Floor, Washington, DC, 20590-0001.
- *Hand Delivery or Courier:* Take comments to Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE, Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.
- *Fax:* Fax comments to Docket Operations at 202-493-2251.

*Privacy:* The FAA will post all comments it receives, without change, to <http://www.regulations.gov/>, including any personal information the commenter provides. Using the search function of the docket website, anyone can find and read the electronic form of all comments received into any FAA docket, including the name of the individual sending the comment (or signing the comment for an association, business, labor union, etc.). DOT's complete Privacy Act Statement can be found in the *Federal Register* published on April 11, 2000 (65 FR 19477-19478).

*Docket:* Background documents or comments received may be read at <http://www.regulations.gov/> at any time. Follow the online instructions for accessing the docket or go to Docket Operations in Room W12-140 of the West Building Ground Floor at 1200 New Jersey Avenue, SE, Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

**FOR FURTHER INFORMATION CONTACT:** John Shelden, Airframe and Cabin Safety Section, AIR-675, Transport Standards Branch, Policy and Innovation Division, Aircraft Certification Service, Federal Aviation Administration, 2200 South 216th Street, Des Moines, Washington 98198; telephone and fax 206-231-3214; e-mail [John.Shelden@faa.gov](mailto:John.Shelden@faa.gov).

**SUPPLEMENTARY INFORMATION:** The substance of these special conditions has been published in the *Federal Register* for public comment in several prior instances with no substantive comments received. The FAA, therefore, finds it unnecessary to delay the effective date and finds that good cause exists for making these special conditions effective upon publication in the *Federal Register*.

### **Comments Invited**

We invite interested people to take part in this rulemaking by sending written comments, data, or views. The most helpful comments reference a specific portion of the special conditions, explain the reason for any recommended change, and include supporting data. We will consider all comments we receive by the closing date for comments. We may change these special conditions based on the comments we receive.

## **Background**

On November 22, 2017, Boeing applied for a change to Type Certificate No. T00021SE for the installation of oblique (side-facing) passenger seats with or without airbag devices or 3-point restraints in the Boeing Model 787-8, 787-9, and 787-10 series airplanes. The Boeing Model 787-8, 787-9, and 787-10 series airplanes are twin-engine, transport category airplanes with a maximum certified passenger capacity of up to 440, and a maximum takeoff weight of approximately 476,000 lbs.

## **Type Certification Basis**

Under the provisions of title 14, Code of Federal Regulations (14 CFR) 21.101, Boeing must show that the Model 787-8, 787-9, and 787-10 series airplanes, as changed, continue to meet the applicable provisions of the regulations listed in Type Certificate No. T00021SE or the applicable regulations in effect on the date of application for the change, except for earlier amendments as agreed upon by the FAA.

If the Administrator finds that the applicable airworthiness regulations (i.e., 14 CFR part 25) do not contain adequate or appropriate safety standards for the Boeing Model 787-8, 787-9, and 787-10 series airplanes because of novel or unusual design features, special conditions are prescribed under the provisions of § 21.16.

Special conditions are initially applicable to the model for which they are issued. Should the type certificate for that model be amended later to include any other model that incorporates the same novel or unusual design feature, or should any other model already included on the same type certificate be modified to incorporate the same novel or unusual design feature, these special conditions would also apply to the other model under § 21.101.

In addition to the applicable airworthiness regulations and special conditions, the Boeing Model 787-8, 787-9, and 787-10 series airplanes must comply with the fuel vent and exhaust emission requirements of 14 CFR part 34 and the noise certification requirements of 14 CFR part 36.

The FAA issues special conditions, as defined in 14 CFR 11.19, in accordance with § 11.38, and they become part of the type certification basis under § 21.101.

### **Novel or Unusual Design Features**

The business-class seating configuration Boeing proposes is novel or unusual due to the seat installation at 30 degrees to the airplane centerline, the airbag-system installation, and the seat/occupant interface with the surrounding furniture that introduces occupant alignment and loading concerns. The proposed business-class seating configuration is also beyond the limits of current acceptable equivalent-level-of-safety findings. These oblique (side-facing) seats may be installed at an angle of 18 to 45 degrees to the airplane centerline and may include a 3-point or airbag restraint system, or both, for occupant restraint and injury protection.

The existing regulations do not provide adequate or appropriate safety standards for occupants of oblique-angled seats with airbag systems. To provide a level of safety that is equivalent to that afforded occupants of forward- and aft-facing seats, additional airworthiness standards, in the form of special conditions, are necessary. These special conditions supplement part 25 and, more specifically, supplement §§ 25.562 and 25.785.

The requirements contained in these special conditions consist of both test conditions and injury pass/fail criteria.

## **Discussion**

The FAA has been conducting and sponsoring research on appropriate injury criteria for oblique (side-facing) seat installations. However, the FAA research program is not complete and we may update these criteria as we obtain further research results. To reflect current research findings, the FAA issued policy statement PS-ANM-25-03-R1 to update injury criteria for fully side-facing seats, and policy statement PS-AIR-25-27, to define injury criteria for oblique (side-facing) seats.

The proposed Boeing Model 787-8, 787-9, and 787-10 series airplanes business-class seat installation is novel such that the current Boeing Model 787-8, 787-9, and 787-10 series airplanes certification basis does not adequately address protection of the occupant's neck and spine for seat configurations that are positioned at an angle greater than 18 degrees from the airplane centerline. The FAA issued special conditions No. 25-580-SC for Model 787-9 airplanes on April 14, 2015, and special conditions No. 25-626-SC for certain Model 787-9 airplanes on July 27, 2016. These special conditions contained injury criteria for oblique seats based on the best knowledge the FAA had at the time. These special conditions for oblique seat installations do not adequately address oblique seats, reflecting the current research results, with or without 3-point or airbag restraint systems. Therefore, Boeing's proposed configuration will require amended special conditions.

The installation of passenger seats at angles of 18 to 45 degrees to the airplane centerline are unique due to the seat/occupant interface with the surrounding furniture that introduces occupant alignment/loading concerns with or without the installation of a 3-point or airbag restraint system, or both. On-going research has invalidated previously

released special conditions for oblique (side-facing) seat installations. These updated special conditions further address potential injuries to the occupant's neck and spine. As a result, these special conditions replace special conditions 25-580-SC and 25-626-SC.

FAA-sponsored research has found that an un-restrained flailing of the upper torso, even when the pelvis and torso are nearly aligned, can produce serious spinal and torso injuries. At lower impact severities, even with significant misalignment between the torso and pelvis, these injuries did not occur. Tests with an FAA H-III anthropomorphic test device (ATD) have identified a level of lumbar spinal tension corresponding to the no-injury impact severity. This level of tension is included as a limit in the special conditions. The spine tension limit selected is conservative with respect to other aviation injury criteria since it corresponds to a no-injury loading condition.

As noted in the special conditions for each airbag restraint system, because an airbag restraint system is essentially a single use device, there is the potential that it could deploy under crash conditions that are not sufficiently severe as to require head injury protection from the airbag restraint system. Since an actual crash is frequently composed of a series of impacts before the airplane comes to rest, this could render the airbag restraint system useless if a larger impact follows the initial impact. This situation does not exist with energy absorbing pads or upper torso restraints, which tend to provide protection according to the severity of the impact. Therefore, the installation of the airbag restraint system should be such that the airbag restraint system will provide protection when it is required, and will not expend its protection when it is not needed.

Because these airbag restraint systems may or may not activate during various crash conditions, the injury criteria listed in these special conditions and in § 25.562 must

be met in an event that is slightly below the activation level of the airbag restraint system. If an airbag restraint system is included with the oblique seats, the system must meet the requirements in one of the airbag (inflatable restraint) special conditions applicable to the Boeing Model 787-8, 787-9, and 787-10 series airplanes.

These amended special conditions will provide head injury criteria, neck injury criteria, spine injury criteria, and body-to-wall contact criteria. They contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

### **Applicability**

As discussed above, these special conditions are applicable to the Boeing Model 787-8, 787-9, and 787-10 series airplanes. Should Boeing apply at a later date for a change to the type certificate to include another model incorporating the same novel or unusual design feature, these special conditions would apply to that model as well.

### **Conclusion**

This action affects only certain novel or unusual design features on one model airplane. It is not a rule of general applicability.

The substance of these special conditions has been subjected to the notice and comment period in several prior instances and has been derived without substantive change from those previously issued. It is unlikely that prior public comment would result in a significant change from the substance contained herein. Therefore, because a delay would significantly affect the certification of the airplane, which is imminent, the FAA has determined that prior public notice and comment are unnecessary and impracticable, and good cause exists for adopting these special conditions upon



publication in the *Federal Register*. The FAA is requesting comments to allow interested persons to submit views that may not have been submitted in response to the prior opportunities for comment described above.

#### **List of Subjects in 14 CFR Part 25**

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

#### **Authority Citation**

The authority citation for these special conditions is as follows:

Authority: 49 U.S.C. 106(f), 106(g), 40113, 44701, 44702, 44704.

#### **The Special Conditions**

Accordingly, pursuant to the authority delegated to me by the Administrator, the following special conditions are issued as part of the type certification basis for Boeing Boeing Model 787-8, 787-9, and 787-10 series airplanes.

#### **Side-Facing Seats Special Conditions.**

In addition to the requirements of § 25.562:

##### **1. Head Injury Criteria:**

Compliance with §25.562(c)(5) is required, except that, if the ATD has no apparent contact with the seat/structure but has contact with an airbag, a head-injury criterion (HIC) unlimited score in excess of 1000 is acceptable, provided the HIC15 score (calculated in accordance with 49 CFR 571.208) for that contact is less than 700.

##### **2. Body-to-Wall/Furnishing Contact:**

If a seat is installed aft of structure (e.g., an interior wall or furnishing) that does not provide a homogenous contact surface for the expected range of occupants and

yaw angles, then additional analysis and/or test(s) may be required to demonstrate that the injury criteria are met for the area that an occupant could contact. For example, if different yaw angles could result in different airbag performance, then additional analysis or separate test(s) may be necessary to evaluate performance.

### **3. Neck Injury Criteria:**

The seating system must protect the occupant from experiencing serious neck injury. The assessment of neck injury must be conducted with the airbag device activated, unless there is reason to also consider that the neck-injury potential would be higher for impacts below the airbag-device deployment threshold.

- a. The  $N_{ij}$  (calculated in accordance with 49 CFR 571.208) must be below 1.0, where  $N_{ij} = F_z/F_{zc} + M_y/M_{yc}$ , and  $N_{ij}$  critical values are:
  - i.  $F_{zc} = 1530$  lb for tension
  - ii.  $F_{zc} = 1385$  lb for compression
  - iii.  $M_{yc} = 229$  lb-ft in flexion
  - iv.  $M_{yc} = 100$  lb-ft in extension
- b. In addition, peak  $F_z$  must be below 937 lb in tension and 899 lb in compression.
- c. Rotation of the head about its vertical axis, relative to the torso, is limited to 105 degrees in either direction from forward-facing.
- d. The neck must not impact any surface that would produce concentrated loading on the neck.

### **4. Spine and Torso Injury Criteria:**

- a. The lumbar spine tension ( $F_z$ ) cannot exceed 1200 lb.

- b. Significant concentrated loading on the occupant's spine, in the area between the pelvis and shoulders during impact, including rebound, is not acceptable. During this type of contact, the interval for any rearward (X direction) acceleration exceeding 20g must be less than 3 milliseconds as measured by the thoracic instrumentation specified in 49 CFR part 572, subpart E filtered in accordance with SAE International (SAE) recommended practice J211/1, "Instrumentation for Impact Test-Part 1-Electronic Instrumentation."
- c. The occupant must not interact with the armrest or other seat components in any manner significantly different than would be expected for a forward-facing seat installation.

**5. Pelvis Criteria:**

Any part of the load-bearing portion of the bottom of the ATD pelvis must not translate beyond the edges of the seat bottom seat-cushion supporting structure.

**6. Femur Criteria:**

Axial rotation of the upper leg (about the z-axis of the femur per SAE Recommended Practice J211/1) must be limited to 35 degrees from the nominal seated position. Evaluation during rebound does not need to be considered.

**7. ATD and Test Conditions:**

Longitudinal tests conducted to measure the injury criteria above must be performed with the FAA Hybrid III ATD, as described in SAE 1999-01-1609, "A Lumbar Spine Modification to the Hybrid III ATD for Aircraft Seat Tests." The tests

must be conducted with an undeformed floor, at the most-critical yaw cases for injury, and with all lateral structural supports (e.g. armrests or walls) installed.

**Note:** Boeing must demonstrate that the installation of seats via plinths or pallets meets all applicable requirements. Compliance with the guidance contained in policy memorandum PS-ANM-100-2000-00123, “Guidance for Demonstrating Compliance with Seat Dynamic Testing for Plinths and Pallets,” dated February 2, 2000, is acceptable to the FAA.

**8. Inflatable Airbag Restraint Systems Special Conditions:**

If inflatable airbag restraint systems are installed, the airbag systems must meet the requirements in one of the airbag (inflatable restraint) special conditions applicable to the Boeing Model 787-8, 787-9 and 787-10 series airplanes.

Issued in Des Moines, Washington, on September 5, 2018.

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